Radiation Protection and Architecture Utilizing High Temperature Superconducting Magnets

Completed Technology Project (2012 - 2014)

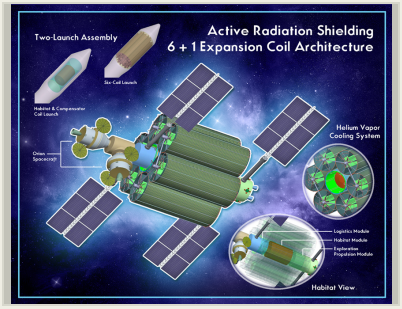
Project Introduction

This study will explore the effectiveness of using electromagnets to protect a habitat from radiation through active radiation shielding.

Active radiation shielding concepts have been studied for many decades as a means to protect crew from deep space radiation environments. These studies yield architectures that are significantly massive and too costly to launch and assemble in space largely due to the magnet size and field strength required to deflect galactic cosmic radiation (GCR) spectra and solar particle events (SPE) for meaningful crew protection in space. Since then state-of-the-art superconducting technology has made great strides in performance including higher temperature superconductivity (HTS) and greater current carrying capacity allowing for simpler magnet cooling systems and greater magnetic field strength per unit mass. During Phase I, the pros and cons of more than 20 potential coil configurations were analyzed by Advanced Magnet Lab (AML) personnel and INFN with the University of Perugia. Substantial progress has been made to develop a feasible solution for the required large HTS coils. The work performed showed that single layer expandable coils with diameters of 4 to 8 m and lengths of 15 to 20 m, arranged in a 6-around-1 configuration constitute the best solution among all concepts analyzed. The single compensator coil closely surrounds the habitat serving as a habitat thermal radiation shield for the outer coils and compensates for outer coil fringe fields trying to enter the habitat. AML has secured separate funding from Space Florida to demonstrate the concept of expandable HTS coils. The phase 2 proposal effort will continue with the creative method of the "expandable" coil concept. The team will refine the structural concept to house such a coil assembly. This will include a more comprehensive structural loads analysis and structural design to manage field forces on each of the coils and the habitat. Concept design and analysis will include effects of the compensation coil on the entire system. The team will evaluate safety implications for the phase 1 coil concept including quench performance, fault scenarios and mitigation strategies.

Anticipated Benefits

Because radiation exposure during long duration space missions poses a significant risk for crewed space-flight, Advanced Magnetic Lab, Inc. (AML) and NASA are studying magnetic radiation shielding, which may generate low-mass protection.



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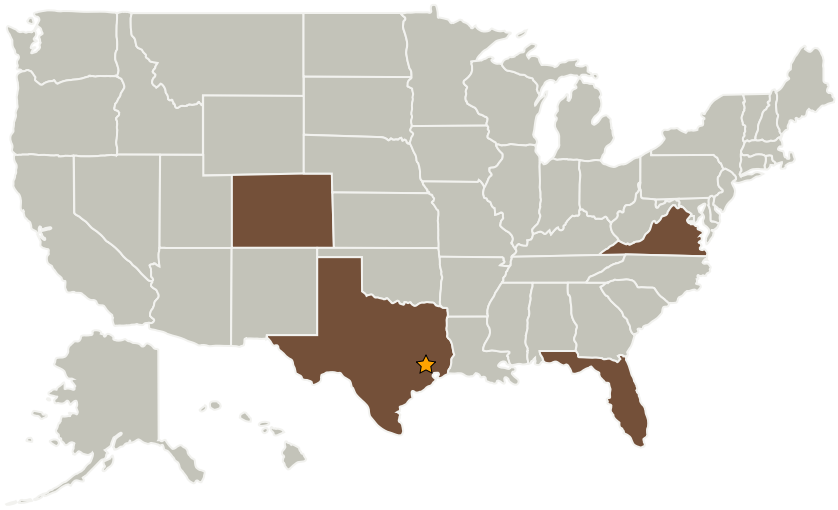
Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

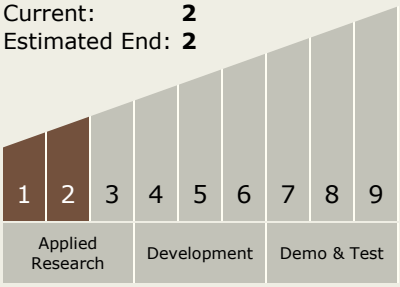
Eric A Eberly

Principal Investigator:

Shayne C Westover

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



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Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Advanced Magnet Lab, Inc.	Supporting Organization	Industry	
Capstone Solutions Group LLC	Supporting Organization	Industry	
Florida State University(FSU)	Supporting Organization	Academia	Tallahassee, Florida
International Space University	Supporting Organization	Academia	Graffenstaden, Outside the United States, France
National Institute for Nuclear Physics(INFN)	Supporting Organization	Academia	Outside the United States, Italy
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado
University of Trento	Supporting Organization	Academia	Trento, Outside the United States, Italy
Università di Perugia	Supporting Organization	Academia	Perugia, Outside the United States, Italy

Primary U.S. Work Locations	
Colorado	Florida
Texas	Virginia

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.5 Radiation
    - TX06.5.3 Protection Systems

Target Destinations

Earth, Foundational Knowledge

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Images

Radiation Protection and Architecture Utilizing High Temperature Superconducting Magnets
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(https://techport.nasa.gov/image/102140)